Physicochemical Characteristics and Environmental Pollution Indicators for Irrigation Agriculture at the Vicinity of River Salanta in Sharada Industrial Areas of Kano State, Nigeria

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Abstract

Physicochemical parameters and surface water pollution indicators were investigated using data matrix from nine water sampling points collected in the morning 6.30am and afternoon 2.00pm along the Salanta Stream making the total of 18 water samples. The water samples were taken to the laboratory for physical and chemical analysis of sixteen parameters namely: Ammonium (NH_4), phosphate (PO_4), Biological oxygen demand (BOD_5), Dissolve oxygen (DO), Calcium (Ca), Sodium (Na), Potassium (K), Magnesium (Mg), Chromium (Cr), Lead (Pb) and Chloride (Cl), (mg/l), Nitrite (NO_2) and Nitrate (NO_3).were analyzed and studied. The results revealed that, the water in the Salanta Stream is controlled by the catchment geology; weathering of silicate minerals from the formation of younger granitic outcrop, dissolve heavy metals and anthropogenic activities from Sharada Industrial areas where effluent is discharge principally with little or no treatment. Therefore, the identification of the main potential water pollution sources in the region by this study will help managers make better and more informed decisions about how to improve the water quality in Salanta Stream for sustainable development.

Keywords: Surface water, Pollution, Salanta Stream, Water Quality

1.1 Introduction

Water resource has becoming increasingly scarce and needs to be sustained, globally and locally. Recycled effluent usage for irrigation is also becoming an increasingly popular practice in many areas of the world, particularly in arid and semiarid regions, where supplies of good quality water are limited or non-existent. In many parts of the world, treated municipal wastewater reuse has been successfully practiced for the irrigation of various crops including forests, agronomic, and horticultural crops, (Ackerson and Awuah 2012). The main obstacle for extending the use of effluents for the irrigation of crops has resulted from their quality. The effluent from different industrial sources has different impacts on the plants because of the different chemical constituents, (Ajon et al. 2014).

In order to get exact idea about the quality of water, it is very essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Water must be tested with different physico-chemical parameters. Selection of parameters for testing of water is solely depends upon for what purpose we are going to use that water and to what extent we need its quality and purity (Mustapha et. al. 2012a). Water does content different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities. Some physical test should be performed for testing of its physical appearance such as temperature, colour, Electrical conductivity, odour, pH, turbidity, Total Dissolve Solid (TDS). Chemical tests should be performing for its Biochemical Chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), alkalinity, hardness and other characters. For obtaining more and more quality and purity water, it should be tested for its trace metal, heavy metal contents and organic constituents i.e. pesticide residue. Only in the developed countries all these criteria's are strictly monitored. Due to very low concentration of heavy metal and organic pesticide impurities present in water it need highly sophisticated analytical instruments and well trained manpower. Following different physico chemical parameters are tested regularly for monitoring quality of water (Mustapha et. al. 2012a).

Irrigation is the artificial application of water to the soil to supplement the water needed by plants for growth, development and productivity. Irrigation also involves the conveyance of water from a source such as rivers, lakes, dams, wells etc. to the farm land for plant use, while Fadama is just the land favoured the used for irrigation activities. However, at the course of irrigation surface and internal soil drainage problem may arise, even in the areas where irrigation water is limiting the problems which attributed largely to a lack of proper farm water management. This is more evident in the developing countries, where irrigation and drainage practices are used as means of putting more land under cultivation. However, they are also the countries where the level of water management and efficiency is very low, (Nauri et. al. 2008). This problem of poor water management, can lead to serious consequences on the soil which causes result of excessive irrigation practice, low soil water infiltration and permeability rates. Furthermore, such condition can prepare ground for the built-up of salinity and sodicity hazards that can affect the crop performance.

There are problems of portable water for irrigation farming in Salanta-Sharada industrial area, due to the wastewater discharged by houses and effluent by industries around the area, this is one of the health hazards likely to be faced by the people living around the area. Poor disposal of harmful chemical substances into the water body untreated from the industries and houses contaminates the River, visibly the water in the River Salanta looked darkish in color of emerging liquid with suspended solids like hair particles, meat scraps and also characterized by a pungent and offensive smell that is disturbing people around the area, and likewise, the water is used for irrigation, while Agricultural irrigation with wastewater has possible public health and environmental side effects, as effluent may contain pathogens, high level of salts, detergents and toxic metals, the use of wastewater has positive effects for farmers, mainly related to their income level, it also has negative effects on human health and the environment. The negative effects impact not only farmers but also a wide range of people. The main aim of this research is to evaluate the water quality of River Salanta for Fadama Irrigation activities with a view to identify the spatial

variations of river water quality for fadama cultivation and to determine the pollution status and its source apportionment influencing the river water quality variations.

1.2 Description of the Study area

Sharada industrial area falls within Kano Municipal Local Government Area which covered areas of about 24Km and has population of 365, 525 (NPC 2006). The people of the area were predominantly traders and small scale farmers, it lies between Latitude $11° 56' 40''$ N and longitude $8° 29' 10''$ E. and it is made up of the following smaller settlements namely; Jaen, Rinji, Mundadu, Anguwar Lere, Gidan Maza, Sabuwar Gandu, (Fig. 1) and other areas making up of the study area include Shagari Quarters down to tributaries of Kano River. Sharada industrial area are broken down into phase I, II and III areas, location are spread over some of these settlements, because of its large area it falls within Kumbotso, Dala and Tarauni Local Government Areas of Kano State,
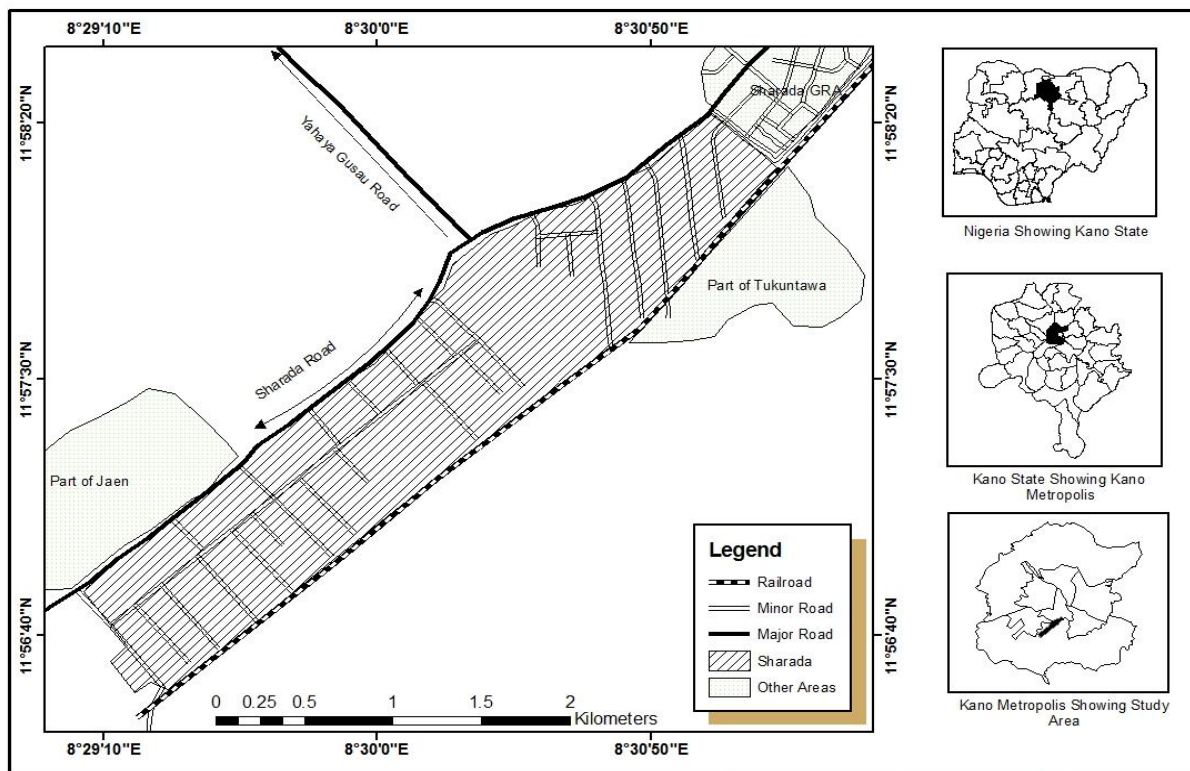

Source: Cartography Lab Geography Department B.U.K (Jun 2013)

Fig 1: Sharada Industrial Area.

Fig 2: Fadama Irrigation Activities in the Study Area

1.3 Research Methodology

The samples of the water was collected at Nine (9) sampling points along the Salanta stream, using composite method of water sampling in which the samples were collected at a regular intervals over a period of time, in a common clean plastic containers over the sampling points, the containers are rinsed with distilled water. Triplicates samples were collected based on the land use activities in the study area (i.e. Industrial area, Residential area and Agricultural area) in order to see if there is variation in pollution status of the parameters used in the study, between each sampling points. Triplicate samples were collected from the discharged point of industrial effluents down to where Salanta stream mixed with the effluents water at the rail way junction (Diga), another triplicate samples were collected around residential areas (Gidan Maza, Sabuwar Gandu and Tukuntawa) down to the junction at which the Salanta River and the effluents water mixed with another river coming down from Rafin Kuka (Gidan Zoo) while the last triplicates samples were collected from the junction, meeting points of the Salanta river, industrial and residential effluents Rafin Kuka Stream to the agricultural site (Fadama cultivation site) around Medille B, Shagari Quarters and Rafin Kuka.

All the 9 samples were collected early in the morning at around 6.30am due to the fact that, the Industries were shut down by that time and another 9 samples were collected again in the afternoon period around 2 pm to 4 pm prompt, where the industries are in full operation so as to see clearly how the effluents concentration in the physicochemical parameters used affect the quality of the water, the total samples was eighteen (18) altogether for the morning and afternoon samples. Each sample was labelled using appropriate code, as A, B, C, D, E, F G H and I. The coordinates of each sampling point's location were taken using global positioning system (GPS).
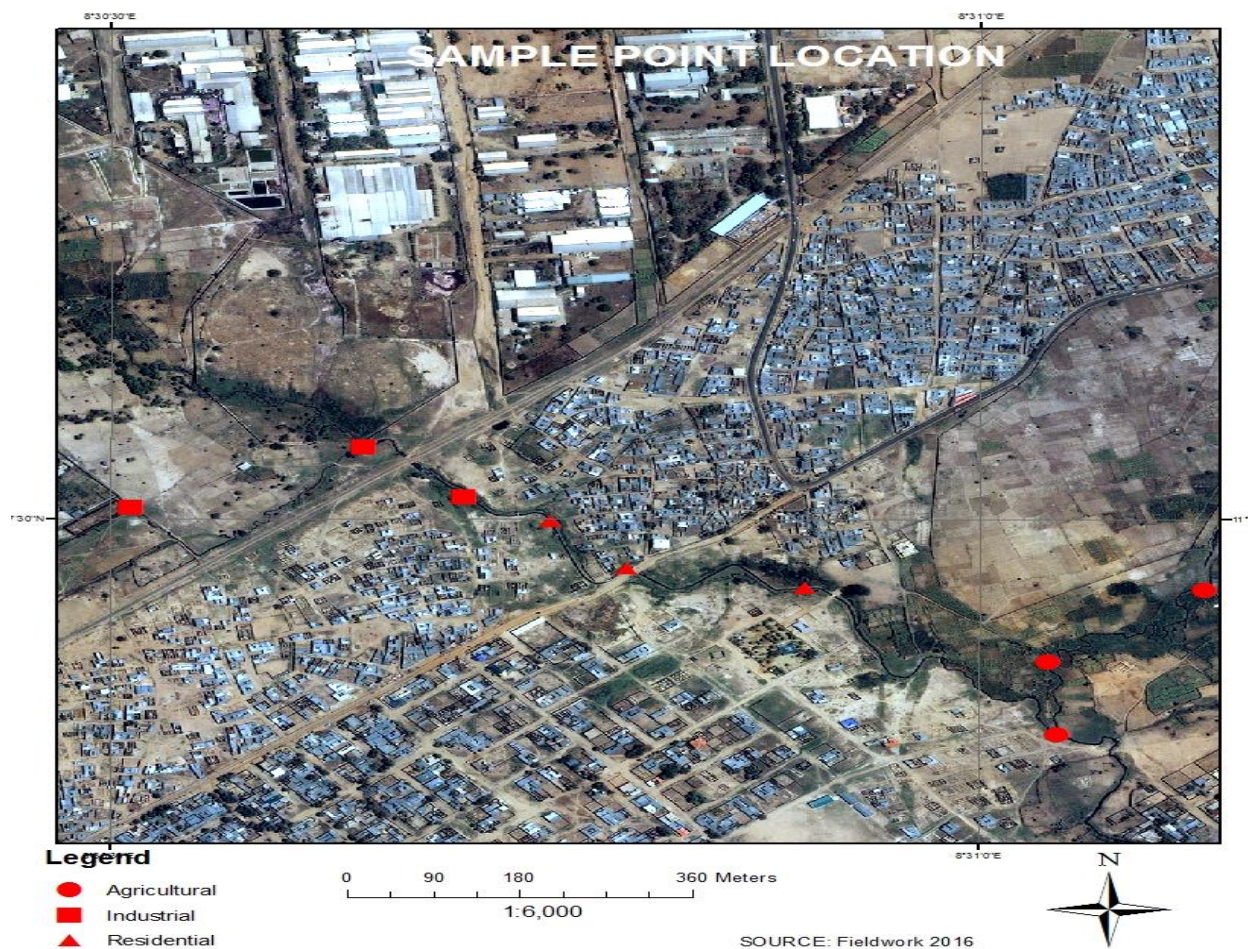
Fig. 3 Location of Sampling Points

The samples were taken to Soil and water laboratory, at Bayero University, Kano (BUK) for physicochemical analysis; the following parameters were tested at the laboratory: Ammonium (NH_4), phosphate (PO_4), Biological oxygen demand (BOD_5), Dissolve oxygen (DO), Calcium (Ca), Sodium (Na), Potassium (K), Magnesium (Mg), Chromium (Cr), Lead (Pb) and Chloride (Cl), (mg/l).

Dissolve oxygen (DO) was determined using Winkler method. After when the samples were carefully collected inside bottles to avoid the splash of solar radiation and sample bottles was stoppered under water in order to prevent the air bubbles from entering the water sample. 2 cm^3 of manganese chloride solution and 2cm^3 of alkaline iodine solution was added to the samples using pipettes, the heavier salt solution was displaced an equal volume of water from the top of the sample bottles filled completely and then shake well to mixed the reagents throughout the water sample. When a complex precipitate of manganic-oxide was formed in direct proportion to the

amount of oxygen presents in the water sample, then the samples now set aside. Then 2 cm^3 of concentrated hydrochloric acid was added and stoppered the bottles and shake vigorously to dissolve the precipitate. Then 50 cm^3 of samples solution was removed and placed in a conical flask. Titrated with 0.01 M sodium thiosulphate solution shake until the yellow colour became pale; then 3 drop of starch solution was added and continues the titration shake until the blue-black colouration of the starch disappeared, then the volume of thiosulphate used was recorded the process was repeated and obtained the mean volume used (x). 1cm^3 of 0.01 M of thiosulphate solution corresponded to 0.0056cm^3 of oxygen at standard temperature and pressure (STP). Then the concentration of oxygen per dm3 of water was calculated using the formula.

Biological oxygen demand (BOD$_5$) was determined following same procedures as DO before incubation and incubated the samples at a room temperature for about 20°C for 5 days. Then stock solution of 0.1m sodium thiosulphate was prepared in a dissolve 24:82g of Na$_2$S$_2$O$_3$5H$_2$O (Sodium thiosulphate) in distilled water added a pellet of NaOH (sodium hydroxide) and diluted to 1cm^3 stored in a brown bottles for 5 days then after incubated for 5days same method were as DO, then less the value obtained from the result obtained before incubation and that of after incubation.

Calcium (Ca), Potassium (K), Sodium (Na), Magnesium (Mg), Chromium (Cr) and Lead (Pb) was measured using Atomic Absorption Spectrophotometer (AAS), by digesting the water sample with concentrated perchloric acid (HCLO$_4$) and taking up the residue in dilute nitric acid, and the standard was prepared from the stock solution by dilution with HNO$_3$. 500ml of water was transferred into a large beaker (750ml capacity), 15ml of HNO$_3$ concentration was added and evaporated on a steam bath to approximately 25ml, then transferred to 50ml acid-washed volumetric flask and brought to volume with deionized water. Then the reading of each element was observed from the spectrophotometer screen after the wavelength was set for each parameter or elements, But Sodium (Na) and potassium (K) was read from Flame photometry.

Phosphate (PO$_4$) was determined using ammonium molybdate under acid condition to form phosphomolybdate complex, using a suitable aliquote of clear filter water sample (10 ml of natural water sample) into a 50-ml Erlenmeyer volumetric flask. Sulfaric Acid solution (H$_2$SO$_4$) was added to the entire sample to bring the solution pH to 5.0 and 8ml of dissolve 1.05gl-Ascorbic acid (C$_6$H$_8$O$_6$) and diluted to 50-ml volume with DL water, mixed well. Standard curved was prepared, 2ml of each standard was pipetted and proceed as for the samples, also a blank with only DL water and proceed as for the samples, the absorbance, standard and samples after 10 minutes on the spectrophotometer at 882 nm wavelength. Then the concentration of the unkown sample was read from the calibrated curve.

Ammonia (NH$_4$) was determined using Nesslerization method, where 20 ml of sample water was pippeted into 100-ml distillation flask, and 1ml of saturated H$_3$BO$_3$ solution was also pippeted into50 ml beaker (duplicate beakers)., 0.2g of heavy MgO was added with a calibrated spoon to distillation flask and attached the distillation flask to the distillation unit with a clamp immediately. The distillation continues for 3 minutes, and then lowered the dish to allow distillate to drain freely into the Pyrex evaporating dish. The first beaker was placed underneath the condenser tip, with the tip touching the solution surface. After like 4minutes when about 40-ml distillate was collected,

then then the steam supply was off, the distillation flask (first distillate) was removed and washed the Teflon-coated magnetic stirring bar with distilled water.

Nitrate (NO_3) was determined using the same method as Ammonia (NH_4), by placing the second beaker underneath the condenser tip, with the tip touching the solution surface, then 0.2g of Devard's alloy was added with a calibrated spoon immediately to the same distillation flask then attached back to distillation unit with a clamp, and started distilling. After like 4minutes again when the 40-ml distillate was collected, then the steam supply was off, and the second distillate flask was removed and the tip condenser was washed with distilled water. Each distillation was contained two standard (pipetted 20 mL 1.2 mg NH_4-N from Diluted Stock Solution,) and two blank (pipetted 20 ml of KCl solution, and 20 ml Dl water for NO_3-N) and recovered for at least 96 %.

Chloride was determined by $AgNO_3$ (Mohrs's titration) method, 10 ml of the water sample was pipetted into a 250-ml Erlenmeyer flask, 4 drops of potassium chromate solution was added, then titrated against $AgNO_3$ solution until a permanent reddish-brown color appeared then titrated 10 ml 0.01N NaCl solution against 0.01 N $AgNO_3$ after 4 drops of potassium chromate was added and redish-brown color appeared, then the reading was taken and calculated $AgNO_3$ normality:

1.4 Results and Discussion

The results of each parameter used in the water samples and the mean values of the parameter analyzed in the laboratory were compared with the standards and establish whether it's permissible for the irrigation cultivation or not. The results further discussed the significant of each parameter and the consequences of its high concentration to the water and soil. The results also were subjected to statistical analysis of both the inferential and multivariate statistics in order to test the hypothesis and to achieve the research objectives specified. Table 1 presents the Sampling location and it's description and coordinates of the study area.

Table 1 Sampling location, coordinates, and description of the study area.

S/N	Sampling points	Coordinates		Land use
		Latitude	**Longitude**	
1.	A	11º57'30.871''N	8º30'30.329E	Sharada Industrial Area (effluent discharge point)
2.	B	11º57'34.328''N	8º38'0.754''E	Railway Diga, Sharada Industria area.
3.	C	11º57'31.499''N	8º30'41.843''E	Behind railway Sharada (Industrial area)
4.	D	11º57'30.29''N	8º30'45.136''E	Gidan Maza (residential area)
5.	E	11º57'28.569''N	8º30'45.55''E	SabuwarGandu (residential area)

6.	F	11°57'27.157''N	8°30'48.226''E	Tukuntawa (residential area)
7.	G	11°57'18.778''N	8°31'2.224''E	Medille B. (Agricultural area)
8.	H	11°57'22.727''N	8°31'2.32''E	Shagari Qtrs. (Agricultural area)
9.	I	11°57'26.583''N	8°31'7.865''E	Rafin Kuka (Agricultural area)

Table 2 and 3 present the results of the physicochemical parameters tested at each points and between the two different times (morning and afternoon samples), it also shows the mean values of each parameter at a sampling points.

Table 2 Summary of the physicochemical parameters result of the sample water (Morning)

Sampling	A	B	C	D	E	F	G	H	I	Mean
pH	6.80	6.80	7.00	7.00	7.00	7.00	7.20	7.40	7.20	7.04
TDS (mg/l)	2140.00	1029.00	1122.00	911.00	871.00	810.00	530.00	402.00	406.00	913.40
EC (us/cm)	3590.00	1734.00	1850.00	1502.00	1446.00	1334.00	861.00	670.00	680.00	1518.00
TEMP ($^{\circ}$C)	22.80	22.30	22.40	22.00	22.00	21.50	22.20	22.20	22.30	22.10
Na (mg/l)	27.10	20.00	21.29	18.71	20.00	20.65	16.13	12.90	6.45	18.14
Mg (mg/l)	0.40	0.40	0.60	0.20	0.40	0.20	0.40	0.40	0.40	0.38
Ca (mg/l)	5.50	4.33	4.83	4.17	5.50	6.00	5.50	3.67	4.17	4.85
K (mg/l)	11.04	10.21	11.86	13.84	12.03	12.19	11.53	10.71	10.54	11.55
Pb (mg/l)	0.09	0.09	0.09	0.09	0.04	0.09	0.04	0.17	0.13	0.09
Cr (mg/l)	0.30	0.07	0.11	0.11	0.07	0.04	0.07	0.04	0.07	0.10
Cl (mg/l)	1082.80	986.90	568.00	461.50	383.40	213.00	213.00	106.50	106.50	457.95
PO$_4$ (mg/l)	34.22	33.53	34.22	44.00	39.11	36.32	38.41	38.41	39.11	37.48
SO$_4$ (mg/l)	0.30	0.16	0.14	0.17	0.18	0.10	0.05	0.04	0.05	0.13
NH$_4$ (mg/l)	112.08	60.24	68.65	77.06	49.04	42.03	19.61	21.02	29.42	53.24
NO$_3$ (mg/l)	11.21	4.19	7.01	11.21	5.60	9.81	7.01	8.41	7.01	7.94
NO$_2$ (mg/l)	8.32	3.11	5.20	8.32	4.16	7.28	5.20	6.24	5.20	5.89
BOD$_5$ (mg/l)	69.40	104.40	138.20	124.60	124.80	0.80	155.80	239.20	10.48	107.52
DO (mg/l)	120.00	222.00	198.00	189.00	180.00	240.00	234.00	331.20	102.48	201.85

Table 3 Summary of the physicochemical parameters result of the sample water (Afternoon)

Sampling	A	B	C	D	E	F	G	H	I	Mean
pH	7.6	7.8	7.2	6.8	7.2	6.8	7.4	7.4	7.4	7.3
TDS (mg/l)	2050.0	2260.0	1604.0	1888.0	1669.0	1424.0	1065.0	465.0	462.0	1431.9
EC (us/cm)	2420.0	3940.0	2670.0	3270.0	2650.0	2170.0	1758.0	758.0	760.0	2079.0
TEMP(°C)	23.2	23.1	23.2	23.3	23.5	23.5	23.4	23.4	23.4	23.3
Na (mg/l)	40.6	37.4	32.9	37.4	34.2	31.0	31.0	14.8	14.8	30.5
Mg (mg/l)	0.4	0.2	0.2	0.4	0.6	0.4	0.4	0.4	0.4	0.4
Ca (mg/l)	4.8	1.7	9.3	7.2	9.0	14.2	17.7	4.8	4.8	8.2
K (mg/l)	11.5	8.1	12.9	14.5	13.3	13.7	24.7	11.7	11.7	13.6
Pb (mg/l)	0.2	0.1	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.2
Cr (mg/l)	0.3	0.1	0.1	0.1	0.1	0.0	0.3	0.1	0.1	0.1
Cl (mg/l)	319.5	142.0	177.5	142.0	284.0	177.5	461.5	213.0	142.0	228.8
PO_4 (mg/l)	37.7	41.2	39.8	40.5	30.0	32.8	31.4	39.8	40.5	37.1
SO_4 (mg/l)	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2
NH_4 (mg/l)	487.5	9.8	113.5	78.5	85.5	2.8	1.4	1.4	1.4	86.9
NO_3 (mg/l)	68.6	134.5	23.8	7.0	21.0	2.8	2.8	1.4	1.4	29.3
NO_2 (mg/l)	50.9	99.8	17.7	5.2	15.6	2.1	2.1	1.0	1.0	21.7
BOD_5(mg/l)	78.6	10.0	83.2	20.8	78.0	105.0	156.8	93.8	96.8	80.3
DO (mg/l)	105.0	54.0	114.0	99.0	120.0	153.0	243.8	174.8	188.6	139.1

1.4.1 pH, Electrical Conductivity (EC), Temperature and Total Dissolve Solid (TDS) Concentrations in the sample water

In this research, The mean value of the pH result from the water samples collected in the morning was 7.04, and the mean value of the pH from the samples water collected in the afternoon was 7.28, while the total mean of the pH values observed from the whole samples in the water was 7.16, and the recommended value of the pH for irrigation by FAO (1994) is 6.5 – 8.4. This shows that the water is within the permissible limit for irrigation cultivation so far as the pH concern in this finding and the water is said to be slightly alkaline since it falls within the range of 7.04. pH is a measure of the acidity or alkalinity of water and is one of the stable measurements. It is a simple parameter but is extremely important, since most of the chemical reactions in aquatic environment are controlled by any change in its value. Anything either highly acidic or alkaline would kill marine life. Aquatic organisms are sensitive to pH changes and biological treatment requires pH control or monitoring. The toxicity of heavy metals also gets enhanced at particular pH levels.

Moreover, pH is having primary importance in deciding the quality of wastewater effluent, according to Onojake (2011), waters with pH value of about 10 are exceptional and may reflect contamination by strong base such as NaOH and $Ca(OH)_2$. Omo-Irabor (2008) opined that, pH important in determining the corrosive nature of water that the lower the pH value the higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity. The reduced rate of photosynthetic activity the assimilation of carbon dioxide and bicarbonates which are ultimately responsible for increase in pH, the low oxygen values coincided with high temperature during the summer month. Various factors bring about changes in the pH of water. The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to changes in physicochemical condition (Papazova and Simeonova, 2013).

In this research finding, the mean value of EC observed from the water samples collected in the morning and afternoon was 1518 us/cm and 2079 us/cm respectively, while the total mean value of EC in the whole samples was 1799 us/cm. Comparing this value with FAO (1994) at 3000 us/cm, it indicated that the EC of the water is within the permissible limit, but values are a bit higher more especially in afternoon sample which is above us/cm approaching the higher limit, if proper management care of the water treatment is not put in place, it will reach above the acceptable limit.

EC in water shows significant correlation with other parameters such as temperature, pH, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand, and chlorides concentration in water. Papaioannou et. al. (2010) reported that, the conductivity of water should be checked.

The mean value of temperature observed in the study for both morning and afternoon samples was 22.1°C and 23.3°C respectively. The total value of temperature at the whole samples water was 22.76°C. While the permissible limit of temperature result in the water for irrigation as documented

by FAO (1994) was 25°C. Temperature is within the acceptable limit of FAO (1994) for irrigation cultivation. Temperature measures the degree of hotness or coldness of the water, in an established system the water temperature controls the rate of all chemical reactions, and affects fish growth, reproduction and immunity. Drastic temperature changes can be fatal to fish and other aquatic life, while the effluents discharges from industries may likely increase the temperature of the water. The diurnal variations of the weather may also likely to temper with the water temperature. An increase in temperature affects almost all chemical reaction in water and it influences the microbial activities and weathering. (Mustapha et. al. 2012b).

The average value of TDS observed from the samples collected in the morning and afternoon period was 913.4 (mg/L) and 1431.88 (mg/L) respectively and the total mean value of TDS for the whole sample was observed to be 1172.66 (mg/L).While, the recommended value of TDS for irrigation water, set by FAO (1994) is 2000 (mg/L). Therefore, TDS is within the acceptable value for irrigation as far as this findings, though, the values is higher in the afternoon samples, with time, if there is no effective and proper monitoring of the water quality, the concentration of TDS will keep on going to an extent where it may fall above the permissible range.

Total dissolve solid content in water is a measure for salinity. A large number of salts are found dissolved in natural waters, the common ones are carbonates, bicarbonates, chlorides, sulphates, phosphates, and nitrates of calcium, magnesium, sodium, potassium, iron, and manganese, etc. A high content of dissolved solid elements affects the density of water, influences osmoregulation of freshwater in organisms, reduces solubility of gases (like oxygen) and utility, of water for drinking, irrigational, and industrial purposes. Waters can be classified based on the concentration of TDS. Silva et. al. (2012), reported that the desirable range useful for irrigation (up to 2,000 mg/L) not useful for drinking and irrigation (above 3,000 mg/L).

1.4.2 Magnesium (Mg), Calcium (Ca), Potassium (K) and Sodium (Na) Concentrations in the sample water

The mean value of Magnesium observed from the morning and afternoon water samples was 0.377 (mg/L) and 0.377 (mg/L) respectively, while the Total mean value of Magnesium in the whole water samples was 0.377 (mg/L), the recommended value of magnesium for irrigation water as set by FAO (1994) is 60 (mg/L) when comparing the value with that of FAO (1994), it shows that, the concentration of magnesium in the water is very small which may likely resulted from the high concentration of the potassium above, while magnesium and calcium are Accountable for most of hardness and Scale-forming properties of water. (Sheykhi and Moore, 2012).

The mean value of Calcium observed from the morning and afternoon water samples was 4.852 (mg/L) and 8.1666 (mg/L) respectively, while the Total mean value of calcium in the whole water samples was 6.509 (mg/L). FAO (1994) recommended the value of calcium for irrigation water quality to be 400 (mg/L), with regards to that, the concentration of calcium in the water is too Small, so more calcium is needed from the water in order to reduce the effect of Magnesium and Potassium, because present of calcium and magnesium in large enough quantities in soil will also counter the effects of the sodium and help maintain good soil properties. Crops grown on soils having an imbalance of calcium and magnesium may exhibit toxic symptoms.

The mean value of K observed from the morning and afternoon water samples was 11.550 (mg/L) and 13.563 mg/L respectively, while the total mean value of K in the whole water samples was 12.03 mg/L, and the accepted limits of K for irrigation water set by FAO (1994) is 2.0 mg/L, this shows that the K concentrations in the water samples was very high which and is unsuitable for irrigation purposed, while high concentrations of K may be introduced by magnesium deficiency and iron chlorosis, also an imbalance of magnesium and potassium may be toxic, but the effects of both can be reduced by high calcium levels.

The mean value of Sodium observed from the morning and afternoon water samples was 18.136 (mg/L) and 30.465 (mg/L) respectively, while the Total mean value of Sodium in the whole water samples was 24.301 (mg/L) and the recommended value of Sodium for irrigation water is 920 (mg/L). FAO (1994). Sodium is within the permissible range when comparing with the Standard and it is far below the limit.

Irrigation water containing large amounts of sodium is of special concern due to sodium's effects on the soil and poses a sodium hazard. Sodium hazard is usually expressed in terms of SAR or the sodium adsorption ratio. SAR is calculated from the ratio of sodium to calcium and magnesium. The latter two ions are important since they tend to counter the effects of sodium. For waters containing significant amounts of bicarbonate, the adjusted sodium adsorption ratio (SAR adj) is sometimes used. Continued use of water having a high SAR leads to a breakdown in the physical structure of the soil. Sodium is adsorbed and becomes attached to soil particles. The soil then becomes hard and compact when dry and increasingly impervious to water penetration. According to Rogerson, (2010), high Sodium (Na) may damage plants, when the concentration is > 270 mg/L and harmful to humans especially those with controlled diets.

1.4.3 Chromium (Cr), Lead (Pb), Ammonia (NH4), Nitrate (NO$_3$), Nitrite (NO$_2$) and Chloride (Cl) Concentrations in the sample water

The mean value of Chromium observed from the morning and afternoon water samples was 0.0987 (mg/L) and 0. 13168 (mg/L) respectively, while the Total mean value of Chromium in the whole water samples was 0.115 (mg/L).

The mean value of lead observed from the morning and afternoon water samples was 0.0917(mg/L) and 0. 1787 (mg/L) respectively, while the Total mean value of lead in the whole water samples was 0.135 (mg/L) Can inhibit plant cell growth at very high concentrations.

The mean value of Ammonia observed from the morning and afternoon water samples was 53.283 (mg/L) and 86.862(mg/L) respectively, while the Total mean value of Ammonia in the whole water samples was 70.05 (mg/L), the accepted value of Ammonia in irrigation according to FAO is 5.0 (mg/L) therefore, Ammonia happens to be above the permissible limit.

The mean value of Nitrate observed from the morning and afternoon water samples was 7.937 (mg/L) and 29.265 (mg/L) respectively, while the Total mean value of Nitrate in the whole water samples was 18.601 (mg/L), the recommended value of Nitrate for irrigation water set by FAO (1994), is within the range of 5 – 30. (mg/L), the result show that Nitrate is within the permissible range, but the concentration is a bit higher at the afternoon samples, which is approaching the

severe limit, it indicated an Anthropogenic pollution, causes an increase in growth of algae and other organisms, it also causes dissolution of oxygen very harmful to babies (blue babies) and can even be fatal. (Satheeshkumar and Khan, 2011).

The mean value of Nitrite observed from the morning and afternoon water samples was 5.888 (mg/L) and 21.711 (mg/L) respectively, while the Total mean value of Nitrite in the whole water samples was 13.800 (mg/L), the recommended limit for Nitrites according to FAO (2008) is 1.0 (mg/L) this indicated that the Nitrite is above the standard limit for irrigation.

The mean value of chloride observed from the morning and afternoon water samples was 457.95 (mg/L) and 228.77 (mg/L) respectively, while the Total mean value of Chloride in the whole water samples was 343.363 (mg/L), and the recommended value of Chloride sets by FAO (1994) is 1063 (mg/L), the result shows that Chloride is within the permissible limit of water quality for irrigation purpose.

Chloride occurs in all natural waters in widely varying concentrations. Excessive chloride in potable water is not particularly harmful and the criteria set for this anion are based primarily on palatability and its potentially high corrosiveness. According to Bhujangaiah and Nayak, (2005) Chloride in excess (>250 mg/L) imparts a salty taste to water and people who are not accustomed to high chlorides may be subjected to laxative effects.

1.4.4 Sulphate (SO_4) and Phosphate (PO_4) Concentrations in the sample waters

 The mean value of Sulphate observed from the morning and afternoon water samples was 0.1317 (mg/L) and 0.1679 (mg/L) respectively, while the Total mean value of Sulphate in the whole water samples was 0.149 (mg/L), the acceptable value of Sulphate for irrigation, according to FAO (1994) is 1240 (mg/L),This result is very minimal since it is far below the limit, and Sulphate salts affect sensitive crops by limiting the uptake of calcium and increasing the adsorption of sodium and potassium, resulting in a disturbance in the cationic balance within the plant, it also Indicates; weathering or water rock interaction, SO_4 and Ca in water forms a hard scale in steam boilers, in large quantities, it makes water taste bitter and influences redox reactions in water. (Kura, 2014).

The mean value of Phosphate observed from the morning and afternoon water samples was 37.48 (mg/L) and 37.09 (mg/L) respectively, while the Total mean value of Phosphate in the whole water samples was 37.2 (mg/L). The accepted limit of Phosphate in irrigation water by FAO (2008) is 2.0 (mg/L), this shows that the value is above the acceptable limit.

1.4.5 Biological Oxygen Demand (BOD_5), and Dissolve Oxygen (DO) Concentrations in the sample water

The mean value of BOD_5 observed from the morning and afternoon water samples was 107.52 (mg/L) and 80.33 (mg/L) respectively, while the Total mean value of (BOD_5) in the whole water samples was 93.9 (mg/L). FAO (2008) recommended the limit of BOD for irrigation at 8.0, this make the water unsuitable for irrigation with regards to BOD. BOD test is found to be more sensitive test for organic pollution. The mean value of DO observed from the morning and afternoon water samples was 201.853 (mg/L) and 139.133 (mg/L) respectively, while the Total

mean value of DO in the whole water samples was 93.9 (mg/L). And the recommended limit set by FAO (2008) is > 4.0 which is above the acceptable limit. Dissolve Oxygen (DO) is one of the most important parameter. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. (Onojake et. al. 2011). In the progress of summer, dissolved oxygen decreased due to increase in temperature and also due to increased microbial activity (Nouri et. al. 2008). The high DO in summer is due to increase in temperature and duration of bright sunlight has influence on the % of soluble gases (O_2 & CO_2). During summer the long days and intense sunlight seem to accelerate photosynthesis by phytoplankton, utilizing CO_2 and giving off oxygen. This possibly accounts for the greater qualities of O2 recorded during summer (Shrestha nad Kazama, 2007).

Conclusion

The investigation of the status of the surface water quality at the Salanta Stream Sharada Industrial area has revealed physicochemical variation. Eighteen surface water samples were collected from nine sampling sites. This study revealed the need for sustainable utilization and management of water resources. More attention and proper sanitation and waste disposal systems are needed to maintain the quality of surface water in the study area.

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